

Reg. No. :

1019

Q.P. Code : [23 21 E 07]

(For the candidates admitted from 2023 onwards)

M.Sc. DEGREE EXAMINATION, APRIL 2025.

First/Second Semester

Part III — Mathematics

Elective — FUZZY LOGIC AND FUZZY SETS

Time : Three hours

Maximum : 75 marks

SECTION A — ($10 \times 1 = 10$ marks)

Answer ALL questions.

Choose the correct answer :

1. A fuzzy set is convex if each of its α - cuts is a
_____.
 - (a) Fuzzy set
 - (b) Convex set
 - (c) Fuzzy number
 - (d) None

2. A fuzzy set is normal when $h(A)$ is

- (a) One (b) Two
(c) Three (d) None

3. The cylindrical extension is totally _____

- (a) unbiased (b) biased
(c) equal (d) none

4. Degrees of association can be represented by membership grades in a _____

- (a) Equivalence relation
(b) Fuzzy relation
(c) Fuzzy set
(d) Crisp relation

5. Every set $A \in \mathcal{F}(X)$ for which $m(A) > 0$ is usually called a _____ element.

- (a) Unique (b) Focal
(c) Specific (d) None

6. The probability measure (pro) is required to satisfy the equation $\text{Pro}(A \cup B) = \text{Pro}(A) + \text{Pro}(B)$ for all sets $A, B \in P(X)$ such that

- (a) $A \cup B \neq \emptyset$ (b) $A \cap B \neq \emptyset$
(c) $A = B = \emptyset$ (d) None

7. $f(A)$ assumes the maximum value iff A is _____.

- (a) Maximally (b) Minimally
(c) Convex (d) None

8. The solution of $u(p(x).p(y)) = u(p(x)) + u(p(y))$ is

- (a) $u(a) = -k \log_b a$ (b) $a \log_b k$
(c) $k \log_b a$ (d) None

9. The total amount of conflict between two bodies of evidence is usually expressed by the function $\text{con}(m_1, m_2)$ is equal to

- (a) $\log_2 k$ (b) $\log_2(1 - k)$
(c) $-\log_2(1 - k)$ (d) None

10. For each fuzzy set A , $f(A) = 0$ iff A is a _____.

- (a) crisp set (b) fuzzy set
(c) null set (d) none

SECTION B — (5 × 5 = 25 marks)

Answer ALL questions.

11. (a) If a fuzzy complement C has an equilibrium e_c , then prove that $a > c(a)$ iff $a \geq e_c$.

Or

- (b) For all $a, b \in [0, 1]$, prove that $u(a, b) \leq U_{\max}(a, b)$.

12. (a) Solve the fuzzy relation equation

$$P_0 = \begin{bmatrix} .9 & .5 \\ .7 & .8 \\ 1 & .4 \end{bmatrix} = \begin{bmatrix} .6 & .3 \\ .2 & 1 \end{bmatrix}$$

Or

- (b) Explain ordinary fuzzy homomorphism with example.
13. (a) Prove that $Bel(B) \geq Bel(A)$, wherever $A \subseteq B$ and $Bel(A) + Bel(\bar{A}) \leq 1$.

Or

- (b) Explain the axioms of plausibility measure.

14. (a) If $\mu_A(x) = \frac{1}{1+x}$ and $\mu_B(x) = \frac{1}{1+x^2}$ of two fuzzy sets A and B defined on the set of real numbers : $X = [0, 4]$, then find $f_{c,1}(B)$ and $\hat{f}_{c,1}(B)$.

Or

- (b) Explain the axiom "Branching" of probabilistic information theory.

15. (a) Explain the axiomatic requirements of the function $V: \mu \rightarrow [0, \infty]$, where μ is the set of all basic assignment, then

$$V(m) = \sum_{A \in f} m(A) \log_2 |A|.$$

Or

- (b) Explain the four stages of fuzzy controller.

SECTION C — (5 × 8 = 40 marks)

Answer ALL questions.

16. (a) State the properties of Boolean algebra.

Or

- (b) Write the axioms of fuzzy union and fuzzy intersection.

17. (a) Solve the fuzzy relation equation for the max-min composition

$$P \cdot \begin{bmatrix} .5 & 0 & .3 & 0 \\ .4 & 1 & .3 & 0 \\ 0 & .1 & .1 & .1 \\ .4 & .3 & .3 & .5 \end{bmatrix} = \begin{bmatrix} .5 & .3 & .3 & .1 \\ .5 & .4 & .4 & .2 \end{bmatrix}.$$

Or

- (b) Define partial ordering and prove any four properties of partial ordering.
18. (a) Prove that a belief measure Bel on a finite power set $P(X)$ is a probability measure iff its basic assignment μ is given by $\mu(\{x\}) = Bel(\{x\})$ and $\mu(A) = 0$ for all subsets of X that are not singletons.

Or

- (b) Explain the axioms of fuzzy measure.
19. (a) If m represents a probability distribution on X , then prove that measure of dissonance in evidence becomes equivalent to the Shannon entropy.

Or

- (b) State and prove Gibb's inequality.

20. (a) Explain fuzzy aircraft control.

Or

- (b) Explain the fuzzy model of group decision proposed by Blin.

Reg. No. : 2232A0055

6005

Q.P. Code : [21 21 E 06]

(For the candidates admitted from 2021-2022)

M.Sc. DEGREE EXAMINATION, MAY 2024.

First/Second/Third/Fourth Semester

Mathematics

Ele: FUZZY LOGIC AND FUZZY SETS

Time : Three hours

Maximum : 50 marks

Answer ALL questions.

SECTION A — ($10 \times 1 = 10$ marks)

Choose the correct answer

1. A fuzzy set A is normal when $h(A)$ is

(a) One (b) Two
(c) Three (d) None
2. A fuzzy set is convex if each of its α -cut is a

(a) Fuzzy set (b) convex set
(c) Fuzzy number (d) None

3. A relation between five sets is called as
 (a) binary (b) quaternary
 (c) quinary (d) Ternary
4. A compatibility class that is not properly contained within any other compatibility class is called _____
 (a) minimal compatibility
 (b) Maximal compatibility
 (c) Complete cover
 (d) None
5. The probability measure (PRO) is required to satisfy the equation $PRO(A \cup B) = PRO(A) + PRO(B)$ for all sets $A, B \in P(x)$ such that _____
 (a) $A \cup B \neq \phi$ (b) $A \cap B \neq \phi$
 (c) $A = B = \phi$ (d) None
6. Total ignorance is expressed in terms of the basic assignment by _____ and $m(A) = 0$ for all $A \neq x$
 (a) $m(x) = 0$ (b) $m(x) = 1$
 (c) $m(x) = \phi$ (d) None

7. When all focal elements are _____ the corresponding belief measure is equal to its dual plausibility measure
 (a) Singleton (b) Equal
 (c) Zero (d) None
8. Dempster's rule cannot be used for defining possibilistic non interaction because it does not preserve _____
 (a) Consonance
 (b) Body of Evidence
 (c) Plausibility measure
 (d) None
9. The total amount of conflict between two bodies of evidence is usually expressed by the function $con(m_1, m_2)$ is equal to
 (a) $\log_2 k$ (b) $\log_2(1 - k)$
 (c) $-\log_2(1 - k)$ (d) None
10. If the fuzzy set M of X has no unique maximum then the message is _____
 (a) General (b) Ambiguous
 (c) Strong (d) None

SECTION B — (5 × 3 = 15 marks)

11. (a) Prove that for each $a \in [0,1]$, $da = C(a)$ iff $C(C(a)) = a$, that is when the complement is involute?

Or

- (b) If a complement C has an equilibrium e_c , then prove that $d_{ec} = e_c$.

12. (a) Solve the following fuzzy relation equation

$$P \circ \begin{bmatrix} .9 & .5 \\ .7 & .8 \\ 1 & .4 \end{bmatrix} = \begin{bmatrix} .6 & .3 \\ .2 & 1 \end{bmatrix}$$

Or

- (b) Write the properties of partial ordering.

13. (a) Prove that $Bel(B) \geq Bel(A)$ whenever $A \subseteq B$ and $Bel(CA) + Bel(\overline{A}) \leq 1$

Or

- (b) Let $X = \{a, b, c, d\}$. Given the basic assignment $m(\{a, b, c\}) = 0.5$, $m(\{a, b, d\}) = 0.2$ and $m(x) = 0.3$. Determine the corresponding belief measure.

14. (a) Explain the application of fuzzy relation in the field of meteorology.

Or

- (b) Write three types of Hartley informations.

15. (a) Explain Branching axiom.

Or

- (b) How does the fuzzy set theory is used in medical diagnosis?

SECTION C — (5 × 5 = 25 marks)

16. (a) State the properties of Boolean algebra.

Or

- (b) Prove that $\lim_{w \rightarrow \infty} i_w = \lim_{w \rightarrow \infty} (1 - \min[1 - (1 - a)^w] + (1 - b)^{1/w}) = \min(a, b)$

17. (a) Explain strong fuzzy homomorphism with an example.

Or

- (b) Solve $\begin{bmatrix} P_{11} & P_{12} & P_{13} \\ P_{21} & P_{22} & P_{23} \end{bmatrix} \circ \begin{bmatrix} .9 & .5 \\ .7 & .8 \\ 1 & .4 \end{bmatrix} = \begin{bmatrix} .6 & .3 \\ .2 & 1 \end{bmatrix}$

18. (a) Show that the function Pl determined by
$$Pl(A) = \sum_{B \cap A \neq \emptyset} m(B)$$

Or

- (b) Prove that $Bel(A \cap B) = \min[Bel(A), Bel(B)]$
and $Pl(A \cup B) = \max[Pl(A), Pl(B)]$, $\forall$,
 $A, B \in P(x)$

19. (a) State and prove Gibb's inequality.

Or

- (b) Prove that $H(X, Y) \leq H(X) + H(Y)$

20. (a) Explain the method of decision making proposed by Bellman and Zadeh with an example.

Or

- (b) Explain how the fuzzy set theory is applied in interpersonal communication.

18. (a) Explain Plausibility measure.

Or

(b) Let $X = \{a, b, c, d\}$. Given the basic assignment $m(\{a, b, c\}) = 0.5$, $m(\{a, b, d\}) = 0.2$, determine the corresponding belief and plausibility measures.

19. (a) Let M_x and M_y be marginal basic assignments on set X and set Y respectively and set m be a joint basic assignment on $X \times Y$ such that $M(A \times B) = M_x(A) \cdot M_y(B)$, for all $A \in \wp(X)$ and $B \in \wp(Y)$, and then prove that $E(M) = E(M_x) + E(M_y)$.

Or

(b) If m represents a probability distribution on x , then the measure of dissonance in evidence x , then the measure of dissonance in evidence becomes equivalent to the Shannon entropy.

20. (a) Explain fuzzy logic controller.

Or

(b) Explain the method of fuzzy clustering.

Reg. No. :

3150

Q.P. Code : [21 21 E 06]

(For the candidates admitted from 2021 onwards)

M.Sc. DEGREE EXAMINATION, MAY 2023.

First/Second/Third/Fourth Semester

Mathematics

FUZZY LOGIC AND FUZZY SETS

Time : Three hours

Maximum : 50 marks

SECTION A — (10 × 1 = 10 marks)

Answer ALL the questions.

Choose the correct answer.

1. A convex and normalized fuzzy set defined on $\mathbb{R}$ whose membership function is piecewise continuous is called a _____.

- (a) Cardinal number (b) ☒ Fuzzy number
(c) Support (d) None

2. A fuzzy set is convex if each of its α -cuts is a _____.

- (a) Fuzzy set (b) ☒ Convex set
(c) Fuzzy number (d) None

3. Degrees of association can be represented by membership grades in a ____.
- (a) Equivalence relation
(b) Fuzzy relation
 (c) Fuzzy set
 (d) Crisp relation
4. The necessity and possibility measures are related to each other by equation ____.
- (a) $\eta(A) = 1 + \pi(\bar{A})$ **(b) $\eta(A) = 1 - \pi(\bar{A})$**
 (c) $\eta(A) = \pi(\bar{A})$ (d) None
5. Every set $A \in P(X)$ for which $M(A) > 0$ is usually called a ____.
- (a) Evidence (b) Neutral element
(c) Focal element (d) Belief of A
6. If $(\mathcal{F}, m)$ is a consonant body of evidence, then
- (a) $E(m) = E(f)$ (b) $E(m) = 1$
 (c) $E(m) \neq 0$ **(d) $E(m) = 0$**
7. If the fuzzy set M of X has no unique maximum then the message is ____.
- (a) General **(b) Ambiguous**
 (c) Strong (d) None

8. Shannon entropy is expressed by the function $H(P(x) | x \in X)$ ____.
- (a) $\sum_{x \in X} P(x) \log_2 P(x)$ **(b) $-\sum_{x \in X} P(x) \log_2 P(x)$**
 (c) $\sum_{x \in X} P(x) + \log_2 P(x)$ (d) None
9. Hartley's simple information can be defined as
- (a) $I(X) = \log_2 |X|, I(Y) = \log_2 |Y|$**
 (b) $I(X) = \log x, I(Y) = \log y$
 (c) $I(X) + I(Y) = \log x + \log y$
 (d) None
10. The Boltzmann entropy $B(q(x) / x \in [a, b])$ is equal to
- (a) $\int_a^b q(x) \log_2 q(x) dx$
(b) $-\int_a^b q(x) \log_2 q(x) dx$
 (c) $\int_a^b q(x) dx$
 (d) None

SECTION B — (5 × 3 = 15 marks)

Answer ALL questions.

11. (a) For all $a, b \in [0, 1]$, prove that $u(a, b) \leq U_{\max}(a, b)$.

Or

- (b) Prove that every fuzzy complement has at most one equilibrium.

12. (a) Explain fuzzy homomorphism with an example.

Or

- (b) Using binary relation find $M_1 * M_2^T$, where

$$M_1 = \begin{bmatrix} 1 & .2 & 0 & 0 \\ 0 & 0 & .4 & .3 \\ 1 & .2 & 0 & 0 \\ 0 & 0 & .4 & .3 \end{bmatrix} \quad M_2 = \begin{bmatrix} .3 & .6 & 0 & 1 \\ .7 & 0 & 1 & .5 \\ .5 & 0 & 0 & .2 \\ 0 & 0 & 1 & 0 \end{bmatrix}$$

13. (a) Prove that g is a belief function iff $g * \mu$ is a density with value 0 at ϕ .

Or

- (b) Show that the Bel function determine by $Bel(A) = \sum_{B \subseteq A} m(B)$ for any given basic assignment m is a plausibility measure.

14. (a) State three axioms of degrees of fuzziness and describe an index of fuzziness.

Or

- (b) Prove that $H(X) \leq H(X/Y)$.

15. (a) Explain the four stages of operation of fuzzy controller.

Or

- (b) Prove that $H(X, Y) \leq H(X) + H(Y)$.

SECTION C — (5 × 5 = 25 marks)

Answer ALL the questions.

16. (a) Prove that $\lim_{w \rightarrow \infty} \min \left[1, \left(a^w + b^w \right)^{\frac{1}{w}} \right] = \max(a, b)$.

Or

- (b) State the properties of Boolean algebra.

17. (a) Find the transitive max-min closure $R_T(X, X)$ for a fuzzy relation $R(X, X)$ defined by the membership matrix

$$M_R = \begin{bmatrix} .7 & .5 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & .4 & 0 & 0 \\ 0 & 0 & .8 & 0 \end{bmatrix}$$

Or

- (b) Define partial ordering and prove any four properties of partial ordering.

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16
Reg. No. :

5017

Q.P. Code : [19 21 E 22]

(For the candidates admitted from 2019 - 2020)

M.Sc. DEGREE EXAMINATION, NOVEMBER 2023

First Semester

Mathematics

Elective: FUZZY LOGIC AND FUZZY SETS

Time : Three hours

Maximum : 75 marks

SECTION A — ($10 \times 1 = 10$ marks)

Answer ALL questions.

1. A collection of pair wise disjoint non empty subsets of a set is called a _____ of a set.
(a) Union (b) intersection
(c) Partition (d) commutative
2. A fuzzy set A is called normal when $h(A)$ is _____
(a) one (b) Two
(c) Zero (d) None

3. _____ is the only continuous and idempotent.

- (a) $\hat{u}(a, b) = \min(a, b)$ (b) $u(a, b) = \max(a, b)$
- (c) $u(a, b) = i(a, b)$ (d) $u(a, b) > i(a, b)$

4. A compatibility class that is not properly contained within any other compatibility class is called _____

- (a) Minimal compatibility
- (b) Maximal compatibility
- (c) Complete cover
- (d) None

5. The sets x and y are non-interactive (in the probabilistic sense) with respect to p if

- (a) $P(x, y) = P_x(x) \cdot P_y(y)$
- (b) $P(x, y) = P_x(x)$
- (c) $P(x, y) = P_y(y)$
- (d) None

6. Plausibility measure can be defined by associated with belief measures

- (a) $Pl(A) = 1 + Bel(A)$
- (b) $Pl(A) = 1 - Bel(A)$
- (c) $Pl(A) = 1 - Bel(\bar{A})$
- (d) None

7. The necessity distribution function is referred to as necessity measure if its values are restricted to

- (a) zeros (b) ones
- (c) Two (d) None

8. The special subclass of plausibility measures and its dual subclass of belief measures is obtained when focal elements are

- (a) nested (b) singletons
- (c) zero (d) None

9. Hartley's joint information can be defined as

- (a) $I(X) + I(Y) = \log(x + y)$
- (b) $I(X) \cdot I(Y) = \log(xy)$
- (c) $I(x, y) = \log_2 |R|$
- (d) None

10. The solution of $u(P(x) \cdot P(y)) = u(P(x)) + u(P(y))$ is

- (a) $u(a) = k \log_b a$ (b) $u(a) = \log_b a$
 (c) $u(a) = k$ (d) None

SECTION B — (5 × 5 = 25 marks)

Answer ALL questions.

11. (a) Prove that if C is a continuous fuzzy complement, then C has a unique equilibrium.

Or

(b) If a complement C has an equilibrium e_c then prove that $de_c = e_c$

12. (a) Obtain the transitive max-min closure of R

Or

(b) Solve the following fuzzy relation equation

$$P \circ \begin{bmatrix} .9 & .6 & 1 \\ .8 & .8 & .5 \\ .6 & .4 & .6 \end{bmatrix} = [.6 \ .6 \ .5]$$

13. (a) Prove that g is a belief function iff $g * \mu$ is a density with value 0 at ϕ

Or

(b) Show that the function Bel determine by $Bel(A) = \sum_{B \subseteq A} m(B)$ for any given basic assignment m is a plausibility measure.

14. (a) Write three types of Hartley informations.

Or

(b) Explain the application of fuzzy sets in decision making.

15. (a) Explain inter personal communications with example.

Or

(b) Explain the application of fuzzy sets in mechanical engineering.

SECTION C — (5 × 8 = 40 marks)

Answer ALL questions

16. (a) State the properties of Boolean algebra.

Or

(b) Prove that $\lim_{w \rightarrow \infty} \min \{1, (a^w + b^w)^{1/w}\} = \max(a, b)$

17. (a) Given

$$Q = \begin{bmatrix} .1 & .4 & .5 & .1 \\ .9 & .7 & .2 & 0 \\ .8 & 1 & .5 & 0 \\ 1 & .3 & .6 & 0 \end{bmatrix} \text{ and } r = [.8 \ .7 \ .5 \ 0]$$

Determine all the solutions of $P \circ Q = r$

Or

- (b) State five properties of partial orderings.

18. (a) Explain the axioms of fuzzy measure.

Or

- (b) Prove that a belief measure Bel on a finite power set $P(X)$ is a probability measure iff its basic assignment M is given by $M(\{x\}) = Bel(\{x\})$ and $M(A) = 0$ for all subsets of X that are not single tons.

19. (a) Explain the method of fuzzy clustering with example.

Or

- (b) Prove that $I(N) = \log_2 N$ is the only function satisfying

(i) $I(N \cdot M) = I(N) + I(M)$

(ii) $I(N) \leq I(N + 1)$

(iii) $I(2) = 1$

20. (a) Explain the fuzzy model of group decision proposed by Blin.

Or

- (b) Explain fuzzy traffic control.

Reg. No. :

4606

Q.P. Code : [19 21 E 22]

(For the candidates admitted from 2019–2020 onwards)

M.Sc. DEGREE EXAMINATION, JUNE 2022.

First Semester

Mathematics

Elective – FUZZY LOGIC AND FUZZY SETS

Time : Three hours

Maximum : 75 marks

SECTION A — ($10 \times 1 = 10$ marks)

Answer ALL questions.

1. Every fuzzy complement has atmost _____ equilibrium.

(a) One

(b) Two

☒ (c) Three

(d) None

2. A fuzzy set A is called normal when $h(A)$ is _____.

☒ (a) One

(b) Two

(c) Zero

(d) None

4

3. Degrees of association can be represented by the membership grades in a _____.

- (a) Equivalence relation
- ☒ (b) Fuzzy relation
- (c) Fuzzy set
- (d) Crisp relation

4. A crisp binary relation $R(X,Y)$ that is reflexive, symmetric and transitive is called _____.

- ☒ (a) Equivalence relation
- (b) Composite
- (c) Commutative
- (d) None

5. Every set $A \in P(X)$ for which $M(A) > 0$ is usually called a _____.

- ☒ (a) Evidence
- (b) Neutral element
- ☒ (c) Focal element
- (d) Belief of A

6. If $(\mathcal{F}, m)$ is a consonant body of evidence, then

- (a) $E(m) = E(f)$
- (b) $E(m) = 1$
- (c) $E(m) \neq 0$
- ☒ (d) $E(m) = 0$

7. Dempster's rule cannot be used for defining possibilistic non interaction because it does not preserve _____.

- ☒ (a) Consonance
- (b) Body of evidence
- (c) Plausibility measure
- (d) None

8. If the fuzzy set M of X has no unique maximum then the message is _____.

- (a) General
- ☒ (b) Ambiguous
- (c) Strong
- (d) None

9. If $P(x_1), P(x_2), \dots, P(x_n)$ represent the probabilities associated with each of the signals $x_1, x_2, \dots, x_n \in x$, then the probability of the event of the receipt of message M is given by

- (a) $P(m) = \sum_{x \in X} \mu(x)P(x)$
- (b) $P(m) = \sum_{x \in X} P_\mu(x)$
- (c) $P(m) = \sum_{x \in X} \mu_p(x)$
- ☒ (d) $P(m) = \sum_{x \in X} \mu_m(x)P(x)$

10. A fuzzy response set $A \in \mathcal{Y}$ can be generated by composing the appropriateness relation R with the fuzzy message, M _____.

- (a) $A = R / M$ (b) M / R
 (c) RoM (d) None

SECTION B — (5 × 5 = 25 marks)

Answer ALL questions.

11. (a) Summarize the full scope of fuzzy aggregation operation.

Or

- (b) Prove that every continuous fuzzy complement has an equilibrium.

12. (a) Explain the fuzzy homomorphism with an example.

Or

- (b) Using binary relation find $M_1 * M_2^T$, where

$$M_1 = \begin{bmatrix} 1 & .2 & 0 & 0 \\ 0 & 0 & .4 & .3 \\ 1 & .2 & 0 & 0 \\ 0 & 0 & .4 & .3 \end{bmatrix}$$

and

$$M_2 = \begin{bmatrix} .3 & .6 & 0 & 1 \\ .7 & 0 & 1 & .5 \\ .5 & 0 & 0 & .2 \\ 0 & 0 & 1 & 0 \end{bmatrix}$$

13. (a) Prove that every possibility measure π on $p(x)$ can be uniquely determined by a possibility distribution function.

Or

- (b) Write the inclusion relationship among the main classes of fuzzy measures.

14. (a) If m represents a probability distribution on X , then prove that the measure of dissonance in evidence becomes equivalent to the Shannon entropy.

Or

- (b) Explain the applications of fuzzy relation in the field of meteorology.

15. (a) Explain interpersonal communication with an example.

Or

- (b) Prove that $H(X/Y) = H(X,Y) - H(Y)$.

SECTION C — (5 × 8 = 40 marks)

Answer ALL questions.

16. (a) Define the generalized mean h_α and find $\lim_{\alpha \rightarrow 0} h_\alpha$.

Or

- (b) State the properties of Boolean algebra.

17. (a) Find the transitive max-min closure $R_T(X, X)$ for a fuzzy relation $R(X, X)$ defined by the membership matrix

$$M_R = \begin{bmatrix} .7 & .5 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & .4 & 0 & 0 \\ 0 & 0 & .8 & 0 \end{bmatrix}$$

Or

- (b) Define partial ordering and prove any four properties of partial ordering.

18. (a) Explain plausibility measure.

Or

- (b) Determine the possibility distribution, possibility measure and necessity measure for the distribution defined on $X = \{x_i / i \in N_n\}$ for appropriate values of $n : m_1(.1, .1, .1, 0, .1, .2, .2, .2)$. Assume that $\mu_1 = m(\{x_1, x_2, \dots, x_i\})$, $i \in N_n$.

19. (a) Prove that the function $I(N) = \log_2 N$ is the only function that satisfies $I(N.M) = I(N) + I(M)$ for all $N, M \in N$ through $I(2) = 1$.

Or

- (b) State and prove Gibb's inequality.

20. (a) Explain the method of fuzzy clustering.

Or

- (b) Explain the application of fuzzy set theory in medicine.